SCIENCE

VOL. 86 FRIDAY, JULY 30, 1937 No. 2222

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE ENGINEER AND HIS RELATION TO GOVERNMENT[1]

By Dr. VANNEVAR BUSH

VICE-PRESIDENT AND DEAN OF THE SCHOOL OF ENGINEERING OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

REAL attention is being given to the professional advancement and the technical interests of the profession. We have an enormously complex system of organization of scientists and engineers in this country, and yet no effective single central organization representing *all* engineers and expressing their viewpoint on public questions. We have an elaborate mechanism for bringing advice to bear on scientific and engineering problems as they arise in government, and this mechanism is not utilized to the full.

What is to be done about it? Certainly no solution lies in forming one more society to join the throng. Integration is indicated; and since societies now exist for all the express purposes we have considered, a duplication of effort by a newcomer would simply complicate matters. Rather, the existing mechanism should be simplified and strengthened.

Would it be of aid if the great national organizations, such as the American Institute of Electrical Engineers, were to take official and definite positions on public questions involving engineering? I do not think this is their proper function, for reasons I will discuss. This is being done in some such organizations, and the effect so far has not been especially helpful. It is another thing entirely for the American Institute of Electrical Engineers to provide a forum for the frank discussion of important questions by men of all shades of opinion. In this I believe it has a duty to perform. So far it has not been done, and

[1] Concluding part of an address delivered at an evening session of the American Institute of Electrical Engineers, summer convention, Milwaukee, Wis., June 22, 1937.

the reason seems to be that those in control have not had the courage to take a step which they fear would split the society. Perhaps a frank and fearless discussion on the floor of an American Institute of Electrical Engineers convention of such a problem as that of the proper sphere of activity of government in the generation and distribution of electric power would split the society. I do not think it would. This is certainly a matter of present interest to electrical engineers. If those who are best able to approach it dispassionately and intelligently fear to open the question at all, how is public opinion to be influenced? In the membership of the institute are men who hold all sorts of opinions on this subject, many of them violently. Many will not express their honest opinions because of their affiliations with government or with public utilities. But there are many more who can and will bring light upon the subject, and, like all subjects of great controversy, it has at least two sides. When I speak of a free forum in this connection I do not mean one where the floor is open to the public. I have in mind one where the participants are carefully chosen for their ability to present their views clearly and calmly, and carefully chosen to bring out all shades of opinion. Such an airing of views on this and many other matters would do a great deal of good. A similar benefit will result when professional publications carry powerful expositions and arguments on the live issues of the day, again with an opportunity for accomplished representatives of all sides to be heard. But the institute itself should express no opinion on this or any other controversial question where its membership holds diverse views. It can not at once be the guardian of a free forum and an advocate. Still it should certainly not be an ostrich.

This taking of stands should be left to a body having that as its primary function. That body should be made up of men of great distinction in the profession, chosen for the purpose by the membership of the profession directly. It should use every legitimate means to be well known to the membership, by questionnaires, publications and by reasonable publicity in regard to its deliberations and findings. It should be absolutely without fear and without prejudice. Its pronouncements should be front page news in every corner of the land. It should enter into any public question involving engineering as a right and without invitation. It should not hesitate to swing public opinion by rousing the profession when such action is indicated. In order that it may speak with a single voice it should represent engineers only, of course with deference to the opinions of other professional groups. We do not have this situation to-day. The metamorphosis of existing organizations, under the guidance of public-spirited engineers, may bring it to pass. As it proceeds it should have the aggressive support of every engineer who has the good of his country at heart, whether or not he agrees with its findings in every respect.

The technique of applying the pressure of engineering opinion on great public questions is only one aspect of our problem. Another aspect involves the advice by engineers to government on specific technical problems. This is a large question and one that involves many of us in one way or another, as citizens and taxpayers as well as engineers.

Government Needs Independent Consulting Engineers

That there is an elaborate mechanism by which government departments may secure the advice of scientists and engineers has been shown. For several reasons, this is not sufficient for the purpose. First, the way is indirect, through an organization that is preponderantly scientific. With the best intentions in the world such an organization can not function precisely and promptly to bring to bear on a great national engineering problem the best engineering brains to be had anywhere; only a few of the great engineers of the country are directly affiliated with it; and the indirect path is cumbersome. The complexities and inertia of this situation were overcome in time of war and in time of great depression, but during normal times the mechanism works feebly. Second, to wait to be called upon in a busy world is not enough, and the present organization has a natural and proper hesitancy to press itself into controversial matters. Third, the setting up of distinguished boards of review on a voluntary basis is not enough.

One can not give sound advice on important engineering matters without spending considerable time and money. This is the function of the independent consulting engineer. We will not be on sound ground in this country until government, on a basis of adequate and dignified fees, calls for the opinions of independent consulting engineers whenever it has an important engineering problem. This it does not do at the present time to any determining extent. If, when the subject has been deeply studied and reports have been presented, the government wishes review by distinguished boards, it always will find men ready to give their services as a matter of public duty. The main reliance, however, must be upon independent consulting engineers, and I wish to make a plea on their behalf.

There are many engineers—many able engineers—in government itself, and these are utilized by government when it has an engineering project to carry out. Army engineers have carried forward on a high plane many outstanding engineering works. The Reclamation Service conducts a research laboratory that is second to none. But the government engineer is not

an independent engineer, and the latter is sorely needed. Given a definite project the government engineer can carry it forward; but he can not at the same time say that it is a foolish thing to carry out at all, even if his engineering studies convince him that it is. Here is a point at which a democracy is at an advantage compared with an absolute government. The dictator has *only* government engineers—units in a rigid machine. Independence of thought and speech there can not be tolerated. Yet, having the advantage as a democracy of the presence of engineers of real independence, we do not make use of them. This is partly because truly independent engineers are becoming rare; partly because unfortunately government is sometimes not anxious that the full truth be known; partly the fault of the engineers themselves. This matter is worth discussing briefly, for it is truly unfortunate if one of the great assets of a democracy is being thrown away.

The rise of great industries in this country, with their own engineering organizations, has restricted the field of operation of independent consultants. The tendency to extend free engineering services as part of the sales programs of large companies similarly has encroached. Fortunately, industry by and large can not maintain engineering departments capable of coping with the unusual, and these peaks are surmounted by calling in the temporary services of independent engineering organizations. Yet the way of the consultant has not been easy, and the number of men who are truly independent, who have seasoned opinions based upon wide experience in many fields, is not large. This is distinctly the fault of government. There should be more utilization of men of the type of John F. Stevens called for service at the Panama Canal. If it were our practice in this country for government to employ independent engineers frequently, the number of such engineers would be greater. When government calls on the engineer at all, it usually attempts to do so on a niggardly basis. It appears to attempt to starve out a group upon which it distinctly needs to lean.

But part of the fault lies with engineers themselves. While we deplore any reluctance on the part of government to let the full light of reason play on its plans for engineering works, we must admit at the same time that the approach of engineers often has not been based upon a sufficiently broad consideration of these very matters. To show that a government engineering work will not pay an adequate financial return on the original investment is not necessarily sufficient to condemn it; yet engineers are prone to limit their considerations to a strict cost and yield basis. The building of a battleship can not be justified on this basis. The setting aside of a national forest should not be thus approached with limited logic.

Do not think that I advocate letting down the bars of strict reasoning to which all engineering works should be subjected. I have no sympathy with any waste of public money. To build a great dam to supply electric power in a region already amply supplied with power, to irrigate land in a region of no inhabitants, while farm land stands idle close by, to render navigable a stream that proceeds into a wilderness, are fool pieces of work in any language. Yet I would have the engineer join with the economist, the sociologist, the student of government, that he may grasp problems in their entirety.

Is it foolish to clear slums, and to cause living quarters to be built by subsidy from public monies, for the use of previous slum dwellers on a rental basis that returns only a portion of the direct investment? It may or may not be, and the answer can come only when the engineer works with the sociologist. It may be a decidedly good investment on the part of government from a strictly financial point of view, if the decrease in costs of police, health hazards, hospitalization and social decay, which follow slum clearance, offsets the direct cost of subsidy. But merely because the problem involves more than the matter of direct costs and direct revenues does not excuse government for proceeding without independent advice; it merely emphasizes the need for analysis by professional men of diverse types.

Consulting Engineers in Educational Institutions

Both government and industry should support the independent consultant in this country, that he may be available in time of need. A duty also rests upon our educational system in this same connection. This duty may rest lightly, for the consultant with university affiliations can bring strength to the educational system itself. Much has been said on this subject, and some would block consultation by members of college faculties. This always would be a catastrophe, but especially so at present when the consulting engineering profession needs to be enlarged and supported. Moreover, engineering education must be real, conducted in an atmosphere of success and in close contact with industrial and governmental advance; and the consultant on the faculty can aid greatly in this regard. There are dangers in the relationship, of course, but they can be avoided and the benefits secured. The use of the name of university affiliation, without the substance of educational duties and responsibilities on the part of the consultant, is a perversion. Encouragement of consulting by university administrations should be accompanied by insistence that such contacts be on a high plane and such as to advance the professional standing of both the individual and his institution. The fees charged should be

on a dignified basis and such that there is no unfair competition with consultants who do not combine educational activities. There should be no use of university laboratories in consulting connections except where the institution is fully reimbursed for all costs of having the facilities present, and then only when there is no interference with the use of these facilities for their primary purposes. Educational institutions that have unique research facilities not available elsewhere should make them available so far as possible without impeding educational use, either directly or through those commercial organizations which perform research services for industry. This certainly does not mean, however, that an educational institution should do routine testing for industry where there is a commercial organization capable of performing the work. Industrial research within an educational institution may be a fine thing, when it carries its full costs, when its results become published, and when its presence adds to the educational process of training men capable of coping with industrial research problems after graduation. But neither the educational institution itself nor the consultant who is a member of its faculty should carry on activities that tend to lower the plane of independent consultants or independent commercial research laboratories. When these matters are realized, the presence of a consultant on a faculty may be of benefit to the institution and render available one more independent engineer for advice to government and industry.

There are many ways in which the individual engineer makes contact with government, and several in which a more intimate contact would be of benefit. One important way lies in the growth of the commission form of activity. These commissions usually, as in the case of the Federal Communications Commission, the United States Shipping Board and the Tariff Commission, are essentially groups of experts within the frame of government itself. So also are such units as port authorities, irrigation district authorities and the like, set up within our still flexible frame of government to unite the administration of regions having common technical character. These and similar units offer one promising mechanism by which to implement the specific actions of government in technical affairs. The engineer is an important member of all such bodies. By and large they have been decidedly effective. An important element, however, appears to be generally lacking in the movement. Usually such boards depend upon the technical knowledge of their own membership, supplemented only by the examination of witnesses who come before them. They are not amply enabled, by the act which establishes them, to increase their grasp and power by temporarily joining to their membership outstanding consultants with special knowledge of the particular problems before them. The independent engineer would find in such association many opportunities to be of genuine service.

Engineers and the Legal System

Another important way in which the engineer makes contact with government is in connection with the legal system, both in law enforcement and in the administration of justice in the courts. This is too large a matter to be treated adequately in an address having a broader subject, yet the point comes up inevitably. There is a real need for close association of scientists and engineers with the legal system at many points, especially in the patent system. The reason is clear. The determination of any legal question depends jointly upon the law and the facts. In a modern technical world the facts are beyond the comprehension of the layman. When dealing with a scientific or engineering subject, the most eminent jurist or attorney is usually decidedly a layman. The result is often sad. Decisions are rendered by judges to whom the facts of a case are in essence incomprehensible. Present procedure is expensive, indeterminate and sometimes ludicrous. Details of procedure aside for the moment, the real reason for this situation is the unwillingness of the legal profession to admit to a basis of partnership the scientist who understands the technical facts of modern civilization, with the attorney who understands the law. We have the spectacle of opposing experts, cross-examined by lawyers who have a week's cramming as a background in the subject under consideration, for the benefit of a judge whose scientific training ended at "Physics I." The childlike faith of most attorneys in this process of elucidating technical facts is beyond comprehension. To the technical man on the sidelines it is often evident that the discussion proceeds to about page 20 of an elementary text, when the true answer lies on page 500 of an advanced treatise. The general atmosphere, charged with suspicion, progressing at a snail's pace, is such that the majority of scientific men engage in legal matters just as little as possible. To expect men of great scientific attainment generally to be willing to take part in this procedure is expecting a great deal from the human race. Yet the members of the legal profession generally regard the presence of a technical adviser to the court, not subject to cross-examination, as an anachronism, and they are perfectly sincere and honest in the opinion. The dilemma is clear. The legal profession, which controls the system, can not itself or through its artifices dealy justly in the type of world in which we now live. It will not have the true cooperation of the best scientific and engineering minds in expeditiously arriving at justice until it welcomes them to something besides a subordinate status. In some of its phases, the legal system has been danger-

ously close to breakdown, and no small portion of this situation is the extent to which it is bogged down in a scientific morass. If breakdown comes, it will be the fault of the profession that molds its affairs and determines its form. Scientists and engineers stand always ready to aid in a matter of public concern and on a basis of professional partnership. In this connection the independent consulting engineer can be of real service in many ways, but space does not permit a detailed examination of them.

Throughout this address I have emphasized the value of independence. So long as this is maintained and there is the effective guidance of affairs by an independent professional class, I have no fear for the future. A true democracy, given this support, can compete with dictatorship and prevail.

Frontiers of Science Still Remain

It was independence of thought, freedom of action, the opportunity of a vast untamed domain that built this country and gave it the highest standard of living in the world. The geographical frontiers have disappeared, but the frontiers of science and technology still remain. Those qualities which built a trail into the wilderness can still build trails in the technological advance. The same qualities of courage, resourcefulness and independence which opened the nation are as necessary to-day as ever.

The growing complexity of life tends to make men cogs. The world is growing smaller, and it is becoming crowded. We "rub elbows" and find increasing dependence upon the activities of our fellow men. The race for economic domination becomes a race, from which we only partially are separated, for military supremacy. The burden on government increases, and the problems arising are more and more beyond the true comprehension of the proletariat. Intense nationalism is in the saddle, and everything, including freedom itself, toward which the human race always has aspired, is being sacrificed for a momentary advantage in the struggle. Nations are turning toward absolutism as a refuge.

Gladstone predicted the decay of democracy if the indigent voter found the power of his vote sufficient to seize arbitrarily and unreasonably the fruits of production. Jefferson himself, the father of American democracy, postulated as a necessary feature of a democratic régime that the bulk of the voters must be tillers of their own land. Whatever we may wish to modify in these opinions, one thing should be added in view of modern conditions. As the social machine becomes more complex and interdependent, it becomes increasingly easy for an aggressive group to disrupt it. The need for discipline is greater, the necessity for restraint of the asocial individual or group is more pressing. Individual freedom, always circumscribed, from the clan up, by the necessity of consideration of the rights of others, becomes inherently narrowed. The right to do this or that ceases to be a right when its performance injures a neighbor; and the ways in which each individual's acts reflect upon the security of his fellows are constantly multiplied. The democratic form of government is adapted to the maintenance of discipline only to the extent that great groups of varied peoples are ready and willing to discipline themselves. The failure to do so in other countries is the primary reason that the people have reverted to absolutism in the hope that it would prove benign. The immediate result, of course, has been to impose discipline, often harshly and in the extreme, to curtail radically individual freedom, and thus to create a state in which efficiency is secured at the sacrifice of much that makes life worth living. The plunge into absolutism is abrupt. The winning of individual liberty is a slow and painful process. Must all democracies go through this cyclic process? Can the great populace, which is governed by its intuitions, its emotions, its mass psychology, grasp this trend and preserve its stability? Moved by the persuasion of those with ulterior interests, who play upon their emotions, can they yet understand the voice of reason? It depends upon whether those who would bring to the people the accumulated wisdom of the ages speak in words that are powerful, genuine and capable of being truly understood; and then it depends only upon whether the people listen and are willing to be guided by the light of reason.

Professional Man Should Make Himself Heard

The free operation of professional classes, motivated by public zeal and altruism, is an anchor upon which our democracy depends to hold it through the storm. There is a great obligation upon the professional man to speak clearly, to insist upon being heard, to maintain his independence. This obligation rests heavily upon engineers.

To be a professional engineer in the true sense does not require that we have some special set of relationships to society and to the organizations of which it is made up. It does require that the primary motivation be the acquisition of scholarship and its generous application to the needs of man.

To be an engineer in these days is to bear a proud title. To be able and willing to speak true opinions on the complex technical affairs of the day, without prejudice and free from control, is a privilege that is becoming rare in the world. Insistent upon his prerogatives, kowtowing to no man, respected because he speaks a truth the country needs to know, the independent engineer stands as an important member of the professional class—a strong bulwark against disaster, which can guide our steps into the ways of pleasantness and into the paths of peace.

THE ULTRACENTRIFUGAL PURIFICATION AND STUDY OF MACROMOLECULAR PROTEINS

By Dr. RALPH W. G. WYCKOFF

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON, N. J.

THE development of air-driven ultracentrifuges provides a new way of preparing and studying proteins and other substances with large molecules. These biological materials have previously been extracted and purified from the tissues in which they occur by chemical methods that ordinarily involve a salting-out with concentrated solutions of ammonium sulfate or similar salts. The successes of Northrop[1] and others in crystallizing several digestive enzymes and of Stanley[2] in preparing crystalline tobacco mosaic virus protein are examples of the fruitfulness of this salting-out process. There are, however, many unstable substances with specific biological properties—such as protein-linked hormones and viruses—to which these chemical procedures have not been successfully applied. Ultracentrifugation, in the sense of centrifuging at speeds sufficiently high so that molecules are actually sedimented, has already provided a number of these less stable proteins in purified form. Not only can the ultracentrifuge thus serve to isolate substances whose molecules are profoundly altered by strong salt solutions, but it furnishes an alternative and often a better way of purifying those biologically active proteins that are amenable to chemical methods of extraction. For example, the globulins in blood serum, including the antibodies, are readily concentrated in the ultracentrifuge without the molecular damage that seems to be the inevitable consequence of ammonium sulfate precipitation; and we are now finding that the molecular homogeneity of most heavy proteins made in the ultracentrifuge is greater than that of the same protein made by the usual chemical methods. In such cases it is hard to avoid the conclusion that the molecular state of the ultracentrifuged sample is nearer that prevailing in the animal or plant from which it is derived.

The ultracentrifuge was first developed by Svedberg[3] about twelve years ago as a means of studying the rates of sedimentation and the particle sizes of colloidal suspensions. He soon found that his methods were equally applicable to the molecules of protein solutions; during the intervening years he has carried his machine to a high degree of perfection and has used it in a remarkable series of investigations into the sizes and shapes of protein molecules.

In spite of the great possibilities inherent in these methods of Svedberg, they were not adopted by others because until recently nobody else could afford them. The air-turbine[4] has figured in several attempts to develop machines[5] for duplicating the type of measurement made by Svedberg. Ours, which we have been using routinely over the last two years, employs the same optical systems as Svedberg's and has rotors of the same size; over the range to which we have applied it—for molecules not smaller than hemoglobin—it yields results of the same accuracy. Its cost is a few per cent. of that of the oil-driven machine.

A great advantage of the air-driven ultracentrifuge lies in the ease with which large volumes of liquid can be centrifuged. For this it is merely necessary to replace the analytical rotor by a suitably shaped block of metal drilled to hold containers for the liquid and equipped with a vacuum-tight cover. Bauer and Pickels[6] first described a quantity head of this type which they used for the concentration of the activity of yellow fever virus. We employed a similar head for the concentration of the horse pneumococcic antibodies[7] from serum and for the crystallization[8] of the tobacco mosaic virus protein from plant juice. During the last few months we have paid considerable attention to the design of these quantity heads. Those now in use hold 150 cc and can be brought to speed, or stopped, in from five to ten minutes, depending on the desired field. If the need should arise still larger volumes undoubtedly could be handled. These rotors can be used to produce fields of between 250,000 and 300,000 times gravity[9]—50 to 100 times the fields developed in ordinary centrifugation.

The use of the centrifuge to isolate materials the size of the larger viruses is not new. Craigie[10] has developed a method of preparing purified suspensions of the elementary bodies of vaccinia which employs

[1] See J. H. Northrop, The Harvey Lectures 1934–5, p. 229 for bibliography.

[2] W. H. Stanley, SCIENCE, 81: 644, 1935; *Jour. Biol. Chem.*, 115: 673, 1936.

[3] See T. Svedberg, *Chemical Reviews*, 20: 81, 1937, for bibliography.

[4] E. Henriot and E. Huguenard, *Compt. rend.*, 180: 1389, 1925; *Jour. phys. radium*, 8: 443, 1927. J. W. Beams and E. G. Pickels, *Rev. Sci. Instr.*, 6: 299, 1935.

[5] J. W. McBain and C. M. O'Sullivan, *Jour. Am. Chem. Soc.*, 57: 2631, 1935; J. Biscoe, E. G. Pickels and R. W. G. Wyckoff, *Jour. Exp. Med.*, 64: 39, 1936; R. W. G. Wyckoff and J. B. Lagsdin, *Rev. Sci. Instr.*, 8: 74, 1937; J. H. Bauer and E. G. Pickels, *Jour. Exp. Med.*, 65: 565, 1937.

[6] J. H. Bauer and E. G. Pickels, *Jour. Exp. Med.*, 64: 303, 1936.

[7] R. W. G. Wyckoff, SCIENCE, 84: 291, 1936.

[8] R. W. G. Wyckoff and R. B. Corey, SCIENCE, 84: 513, 1936.

[9] R. W. G. Wyckoff, SCIENCE, 85: 390, 1937.

[10] J. Craigie and F. O. Wishart, *Brit. Jour. Exp. Path.*, 15: 390, 1934.

the ordinary angle centrifuge. Bechhold and Schlesinger[11] have obtained very concentrated solutions of *B. coli* bacteriophage by coating the inner surface of a container with gelatin and centrifuging until the phage particles or molecules had become embedded in the gelatin layer. New methods of isolation are possible with the quantity ultracentrifuge because it produces fields great enough so that substances with very large molecules are sedimented as solids.

Last summer Stanley and I isolated the unstable protein responsible for the latent mosaic disease of potatoes by ultracentrifuging the juice of infected plants. This plant juice contained, besides the virus protein, much colloidal cellular debris and many unsedimentable proteins and other light materials in solution. After a couple of ultracentrifugations had eliminated most of these impurities a faint, sharply sedimenting boundary was photographed with the analytical ultracentrifuge. The protein causing this boundary was purified by further ultracentrifugations guided by additional observations with the analytical ultracentrifuge. This year in Princeton we[12] have applied the same method to the isolation of other plant virus proteins. Our success led Beard and myself[13] to see whether a similar heavy protein was present in the infectious warty tissue of virus-induced rabbit papillomas. We found such a substance and demonstrated that the virus activity was intimately associated with it. During the last six months more than 100 milligrams of this protein have been prepared and many of its biological, chemical and physical properties determined. Similar heavy proteins[14] have been demonstrated in ultracentrifugal concentrates of other virus-diseased animal tissues, so that it is clear that such pathogenic substances are not uncommon among both plants and animals.

The ultracentrifuge has been useful not only as a means of preparing these unstable virus proteins but as a way of characterizing the protein itself, of determining the degree of its purity and the extent of its concentration at each step in the isolation. A pure protein in true solution consisting of molecules all of the same size and shape will sediment at a constant rate in a sufficiently intense uniform centrifugal field. This rate as measured by the sedimentation constant is greater the heavier the molecule. It is determined by photographing with a suitable optical arrangement the sedimenting boundaries that arise between protein and solvent. Especially when dealing with very heavy molecules, those a million or more in weight, the sharpness of the boundary is an immediate index of homogeneity in molecular size. By studying this sharpness it is possible to follow the spontaneous disintegration of an unstable protein or the extent of molecular damage that has been done by extractive procedures and chemicals. In this way we have recorded the changes brought about in the tobacco mosaic[15] and potato X virus proteins by ammonium sulfate precipitations as well as the alterations that occur when these proteins are aged or left in phosphate buffer solutions. Many other things about the purity of a protein solution can be learned from its sedimentation pictures. It is especially instructive to compare in this manner the inactivation of a virus and the disintegration of its protein molecules. Beard and I[16] have done this for the papilloma protein and shown that the two parallel one another. Heavy proteins fall apart in various ways. Some, like the encephalomyelitis protein,[14] break up into many small "unsedimentable" fragments; others, such as the papilloma protein in strong acid, break into one or two large pieces. Under suitable conditions it is possible to observe a splitting up into pieces that get smaller with time. Many protein denaturations undoubtedly could be followed quantitatively and recorded photographically in this fashion.

Protein molecules do not necessarily fall apart when they change. Thus the secondary boundary that appears in the tobacco mosaic and other proteins with aging or mild chemical treatment is probably an expression of altered molecular shape. The gradual increase in boundary diffuseness that also accompanies some mild chemical treatments can be construed as the result of innumerable minute and varied molecular alterations. Carried to an extreme, these changes lead to a heterogeneity and diffuseness of sedimenting boundary such as are characteristic of a colloidal suspension. A new and interesting phenomenon was encountered during the study of solutions of Northrop's[17] staphylococcus bacteriophage. Chemically purified and highly active solutions of this phage showed a moderately sharp boundary which sedimented at the rate to be expected from a protein molecule with a weight in excess of fifty millions. If such a solution is inactivated by heat, this boundary is replaced by an exceptionally sharp but slowly sedimenting one. It seems evident that the material causing this is not, as one might at first think, made up of small molecules; it is instead a dilute protein gel that within certain limits can lose and reimbibe water.

On account of its success in purifying viruses, most of the applications of quantity ultracentrifugation have been to these disease-producing agents. Some

[11] H. Bechhold, *Kolloid-Zeits.*, 66: 329; 67: 66, 1934; M. Schlesinger, *Biochem. Zeits.*, 264: 6, 1933.

[12] W. M. Stanley and R. W. G. Wyckoff, SCIENCE, 85: 181, 1937.

[13] J. W. Beard and R. W. G. Wyckoff, SCIENCE, 85: 201, 1937.

[14] R. W. G. Wyckoff, *Proc. Soc. Exp. Biol. and Med.*, 36: 771, 1937.

[15] R. W. G. Wyckoff, in press.

[16] R. W. G. Wyckoff and J. W. Beard, *Proc. Soc. Exp. Biol. and Med.*, 36: 562, 1937.

[17] J. H. Northrop, SCIENCE, 84: 90, 1936.

exploratory runs already made with bacterial extracts, with undiseased tissues and particularly with the glands and organs of special function indicate clearly that many other new and biologically important substances can be prepared and studied with the ultracentrifuge.

The virus proteins themselves are of interest to the physical as well as to the biological chemist because they provide the largest known molecules. The researches of Svedberg have shown the existence of normal proteins in a graded progression of sizes up to the hemocyanins with a molecular weight of several millions; recently[18] he has shown pictures of a polymer of thyroglobulin which must weigh about fifteen millions. The viruses, in their turn, reach in an apparently unbroken series from particles with a size somewhat less than that of a hemocyanin molecule up to the microscopically visible elementary bodies of the pox diseases. The analytical ultracentrifuge has demonstrated that in the unaltered state the molecules of several of the smaller virus proteins are of equal size and shape. The elementary bodies of vaccinia also give sharp sedimenting boundaries and hence are of uniform size, but existing experiments are inadequate to show whether they resemble molecules in other ways. All the colloid chemist's investigations thus far have been made on suspensions of more or less heterogeneous particles; working with virus proteins he has at hand substances possessing the molecular properties of a solution of a pure compound.

In spite of the possibilities for research which these very large protein molecules offer to the physical and colloid chemist, their greatest interest to chemists as well as to others must lie in their ability to cause disease. Ever since the filterability through stone filters and the consequent sub-microscopic size of the contagious principle of virus diseases was first demonstrated, there has been debate about the fundamental nature of this principle. Most pathologists have held to the belief that it was an especially small living organism, and research on virus diseases has been dictated by this outlook. From such a standpoint it is inevitable that one should look upon a virus protein not as the virus itself but as some sort of a carrier of a small, living viral agent.

This assumption can hardly be disproved in any individual instance, but rapidly accumulating evidence makes it increasingly difficult to maintain. The detailed work of Stanley[19] on tobacco mosaic virus protein indicates that the infectivity is a property of the protein; and no way has yet been found of dissociating viral activity from the less stable virus proteins prepared with the ultracentrifuge. Except for the tobacco mosaic protein which constitutes so large a part of the total protein of diseased plants, the virus proteins are many times more infectious, per unit weight, than the material from which they are derived. During ultracentrifugal isolation their infectiousness rises as long as the heavy protein is being concentrated; when it is pure, the specific infectivity is not increased by additional centrifugations. The virus and the protein therefore sediment at the same rate. They have other physical properties in common. The encephalomyelitis protein spontaneously disintegrates at much the same rate that governs the disappearance of infectivity; and Beard and I have found that the papilloma protein falls apart at those pH's where the activity immediately disappears. There is a corresponding parallelism between the ultracentrifugal analyses of the pH stability of the tobacco mosaic virus protein molecule and its range of infectiousness. In the face of evidence of this sort the only fruitful standpoint is one which admits that the virus activity may be a property of the heavy substance and seeks in every imaginable way to compare the behaviors of the activity and its associated protein. A new field of research into the mechanism and control of disease is opened up by the possibility of treating its cause as a pure chemical compound. Stanley[20] has found that the virus activity of the tobacco mosaic protein can be destroyed by several simple chemicals without alteration of its immunological specificity. Beard and I[21] have shown that under certain conditions the papilloma protein loses all activity without measurable molecular change. It is not unreasonable to hope that experiments of this type will some day indicate a new way in which the body can be aided in protecting itself against disease.

In addition to supplying the method for such definite experiments the ultracentrifuge makes it possible for the first time to examine a number of intriguing speculations. One wonders, for example, whether molecules the size of virus proteins occur naturally in plants and animals without producing disease. Of special importance is the problem of the mechanism whereby a susceptible living host yields much virus after being infected with only a trace. As long as the smaller viruses were pictured as autonomous living agents preying on their hosts, their multiplication could be thought of as the consequence of processes resembling bacterial division. Viruses that are definite chemical molecules can be imagined not as such extraneous predatory organisms but as products of abnormal metabolic processes within the "infected" cells. We still know far too little about the details of protein chemistry to be able to understand how the introduction of a heavy virus molecule into a living cell induces its protoplasm to break down according to the new

[18] T. Svedberg, *op. cit.*
[19] W. M. Stanley, *Am. Jour. Botany*, 24: 59, 1937.
[20] W. M. Stanley, SCIENCE, 83: 626, 1936.
[21] R. W. G. Wyckoff and J. W. Beard, *op. cit.*

pattern established by this molecule, but the idea is not incompatible with what has already been learned about enzymal action. Because they bridge the gap between the "dead" simpler protein molecules and the unquestionably living smaller bacteria, the viruses are irresistibly attractive to all who are interested in attaching precise meaning to the term "alive." By supplying some of these viruses in pure form the ultracentrifuge permits a new experimental approach to this question.

SCIENTIFIC EVENTS

SCIENTIFIC AWARDS IN CHINA

THE following prizes and awards are recorded in "Science Notes" issued by the College of Natural Science, Yenching University, Peiping, China.

At the annual meeting and dinner of the Peking Society of Natural History held in April, Dr. Chenfu F. Wu, chairman of the department of biology of Yenching University, was the recipient of the King Medal. This medal is awarded annually for distinguished work in the biological or geological sciences. The award this year was bestowed upon Dr. Wu in recognition of his work on "The Catalogue of Chinese Insects."

Recent announcement has been made of the following new fellowship appointments by the China Foundation: Cho Ting-wei (M.S., 1937), for work in general physiology at Wu-Han University; Lin Cho-yuan (M.S., 1934), for research studies in ceramics at Pennsylvania State College; Ch'en Shang-yi (M.S., 1934) for work in spectroscopy at the University of California; Ho Ch'i (B.S., 1928) and Chang Tso-kan (B.S., 1932) for research abroad in biology. A research grant has also been made to Hsu Peng-cheng (M.S., 1935), instructor in chemistry, in support of nutrition studies at Yenching University.

A scholarship for study in England has been awarded to Tai Wen-sai (Graduate Yuan) by the British Boxer Indemnity Fund for work in astrophysics. Pu Chih-lun (Graduate Yuan) has received the Sun Yat-sen Memorial fellowship for work at Yenching University in biology.

In physics, Yuan Chi-liu (M.S., 1934) has been appointed a research fellow at the California Institute of Technology, and Lu Ho-fu (B.S., 1936) has received a similar appointment at the University of Minnesota. Kuang Jung-lu (B.S., 1935) has been awarded a fellowship in veterinary medicine at Cornell University.

Of the four prizes offered to B.S. graduates for the best research theses in physics for the year 1936, in a nation-wide contest sponsored by the Sino-Belgian Boxer Indemnity Committee, two of the prizes were awarded to Lu Ho-fu and Ch'eng Li-ch'ang of the department of physics of Yenching University.

ARCHEOLOGICAL PROJECTS

WATSON DAVIS, director of Science Service, reports that government funds, available through the Works Progress Administration, may be used to give unemployed men and women work on archeological projects which meet with official requirements. It is not, however, within the province of the WPA to seek suggestions for such projects, but they are interested in helping scientific research in cases where WPA workers can be employed and they welcome the cooperation of scientific organizations and of scientific men.

A few years ago, Science Service, with the cooperation of the Division of Anthropology and Psychology of the National Research Council, conducted a plan known as the Archeological Minute Men. By that arrangement, rumored discoveries in archeology were reported and were investigated as promptly as possible, and accurate reports were furnished to newspapers. No funds, however, have hitherto been available for excavation.

If an archeological site is discovered which seems worth excavating, a WPA project can be undertaken, provided the project is properly sponsored and supervised, and there is relief labor available in the area. All WPA projects must be sponsored by some public institution or organization such as a public museum, state university, municipal government, state government or board of education. An individual or a private institution must arrange for official sponsorship. The Smithsonian Institution is cooperating with the WPA in reviewing projects.

The WPA will not approve any project which does not have a supervisor with training and ability approved by the WPA coordinating anthropologist. It is requested that names be suggested of individuals who might act in this capacity. It is planned to obtain complete reports on these projects, and to see that the collections obtained are placed in public institutions where they will be properly cared for. A further service that experienced archeologists can render will be to report any vandalism or careless excavation.

Science Service is glad to act as an intermediary in bringing archeologists and the WPA into contact, both because of its desire thus to assist in the promotion of scientific research and because incidentally such excavations should be reported to the public through the service.

A FEDERAL CANCER RESEARCH INSTITUTE

A BILL establishing a Federal Cancer Research Institute at Washington, for which an appropriation of

$75,000 is provided, has been passed by the Senate and by the House and has gone to the President for signature.

The bill authorizes also an appropriation of $700,000 annually. The institute would be established under the direction of the surgeon-general of the Public Health Service. The surgeon-general would serve as *ex-officio* member and chairman of a national advisory cancer council composed of six physicians and scientific men, to be appointed by him with the approval of the Secretary of the Treasury.

The bill directs the council: To review research projects or programs submitted to or initiated by it relating to the study of the cause, prevention or methods of diagnosis of cancer; to collect information as to studies which are being carried on anywhere as to the cause, methods of treatment or diagnosis of the disease; to review applications from any university, hospital, laboratory or other institution, whether public or private, for grants in aid of research projects.

The surgeon-general is authorized to buy radium for use of the institute, or for lending it to those engaged in cancer research.

The Treasury could accept gifts, made unconditionally by will or otherwise, for study, investigation and research into the causes or treatment of cancer. It provides that for all donations of $500,000 or over the council shall acknowledge them with suitable memorials in the institute.

The measure was first introduced by Senator Bone, and subsequently his colleagues asked that their names be placed upon it as sponsors.

THE TREUB FOUNDATION OF BUITENZORG, JAVA

IN 1934 Fairchild and Barbour[1] presented certain facts concerning "The Crisis at Buitenzorg." Since that time it has not been possible for the Government of Netherlands India to support the biological establishments at Buitenzorg as they were once supported. Indeed, the appropriations have been reduced from Fl. 376,000 in 1929 to Fl. 133,500 in 1935. During the same period the sums available for the purchase of materials has been reduced from Fl. 92,000 to Fl. 20,700, and the scientific staff has dwindled from seventeen persons to six.

In order gradually to ameliorate this condition the Treub Foundation has been established with a distinguished group of trustees, which assures the conservative investment and care of any funds which come into their hands. Sundry donations from various parts of the world have already been received, and the Government of Netherlands India has given permission for the sale of surplus plants from the Botanic Garden at Buitenzorg and the Mountain Garden at Tjibodas to private persons and institutions who could formerly obtain them free, and the moneys thus secured have been and are being put into the Treub Fund. An appropriation has already been granted which has made possible the publication on the flora of Krakatau by Dr. D. van Leeuwen. While publication is considered for the future, the object of the foundation is to cooperate in maintaining and extending the scope of the scientific institutions at Buitenzorg and Tjibodas, and, later on, support of the Marine Laboratory at Batavia will also be considered when funds permit.

The foundation recognizes as donors corporations contributing a sum of at least Fl. 1,000 or individuals who contribute a sum of at least Fl. 500; patrons, contributing Fl. 100, and subscribers, contributing at least Fl. 10 a year. Persons who have in the past aided the gardens or who have conducted scientific research in Netherlands India may be appointed corresponding members. These persons are expected, in their own country, to consider the interests of the Buitenzorg institutions, to solicit and receive contributions to be forwarded to the treasurer of the Treub Foundation and in any other way possible to facilitate with advice or information persons who may consider going to Java to make use of the facilities of the scientific establishments there.

The undersigned have been asked to serve as corresponding members of the Treub Foundation in the United States, and they have gladly consented so to serve and hope that, as great results in the past have often come from small beginnings, institutions or individuals who may read these lines and who know of the immeasurably great influence which Buitenzorg has played in the lives of unnumbered naturalists and in the contributions to knowledge which have appeared as a result of the inspiring environment which Dr. Treub brought into existence and which has been continued by his distinguished successors may feel inclined, in great or small degree, to aid in the support of one of the greatest biological establishments in the world.

We recall what Bradford wrote in his "History of Plimmoth Plantation" concerning the origin of Harvard College, when he spoke hopefully concerning the future growth of the university: "Thus out of smalle beginnings greater things have been produsedby His hand that made all things of nothing, and gives being to all things that are; and as one small candle may light a thousand, so the light here kindled hath shone to many, yea in some sort to our whole nation." And Sir Walter Mildmay, when he founded Emmanuel College at Cambridge and was chided by Queen Elizabeth for so doing, as she had no approval for the establishment of a Puritan Foundation, replied, "No, Madam, far be it from me to countenance anything contrary to

[1] SCIENCE, 80: 2063, 33–34.

your established laws; but I have set an acorn, which when it becomes an oak, God alone knows what will be the fruit thereof."

As Mildmay's acorn has grown to a great oak and as Harvard University is now well endowed, we can only hope and, indeed, believe that the same good fortune may, in the future, attend the increase and perpetuation of the Treub Foundation.

DAVID FAIRCHILD
ELMER D. MERRILL
THOMAS BARBOUR

OFFICERS OF THE NATIONAL RESEARCH COUNCIL, 1937–1938

THE National Research Council announces the reappointment of Dr. Ludvig Hektoen, director of the John McCormick Institute for Infectious Diseases in Chicago, as chairman of the council for the year beginning on July 1, 1937.

The officers of the divisions of science and technology of the council for the coming year, among whom are several replacements, are as follows:

Physical Sciences

Luther P. Eisenhart, *chairman;* professor of mathematics and dean of the Graduate School, Princeton University.

H. A. Barton, *vice-chairman;* director of the American Institute of Physics, New York City.

Engineering and Industrial Research

Vannevar Bush, *chairman;* vice-president and dean of the School of Engineering, Massachusetts Institute of Technology.

Howard Poillon, *vice-chairman;* president of the Research Corporation, New York City.

Chemistry and Chemical Technology

Herbert R. Moody, *chairman;* professor of chemistry and director of the chemical laboratories, College of the City of New York.

Geology and Geography

Chester R. Longwell, *chairman;* Henry Barnard Davis professor of geology, Yale University.

Robert S. Platt, *vice-chairman;* associate professor of geography, University of Chicago.

Medical Sciences

Esmond R. Long, *chairman;* professor of pathology, School of Medicine, and director, Henry Phipps Institute, University of Pennsylvania.

Howard T. Karsner, *vice-chairman;* professor of pathology and director of the Institute of Pathology, Western Reserve University.

Biology and Agriculture

R. E. Coker, *chairman;* professor of zoology and chairman of the Division of Natural Sciences, University of North Carolina.

E. C. Stakman, *vice-chairman;* professor of plant pathology, University of Minnesota.

Anthropology and Psychology

W. S. Hunter, *chairman;* professor of psychology, Brown University.

Carl E. Guthe, *vice-chairman;* Director of Museums, University of Michigan.

RECENT DEATHS AND MEMORIALS

MARQUIS GUGLIELMO MARCONI died on July 20 at the age of sixty-three years.

DR. JAMES RAMSAY HUNT, professor of neurology at the Columbia University School of Medicine, died on July 22. He was sixty-three years of age.

SIR CHARLES SAUNDERS, who originated the Canadian "Marquis wheat," died on July 25 at the age of seventy years.

Nature reports the death of Professor A. W. Gibb, emeritus professor of geology in the University of Aberdeen, on July 12, at the age of seventy-three years; and of Dr. A. A. Bialinycki-Birula, formerly director of the Zoological Museum of the Russian Academy of Sciences, known for his zoological work in the Arctic, aged seventy-three years.

THE Charles R. Bardeen Memorial Lecture, honoring the late dean of the Medical School of the University of Wisconsin, was presented on May 24 at the university under the auspices of the Phi Chi fraternity. Dr. Jacob Arnold Bargen, of the Mayo Clinic, gave the lecture on "Recent Advances in Studies on Intestinal Disorders in Europe and America."

A CEREMONY was held at the Franklin Institute on July 22 in memory of the late Frederic Eugene Ives, who died on May 27. His son, Dr. Herbert E. Ives, presented to the institute the original patent and other material from the Ives laboratory.

THE one hundred and fiftieth anniversary of the birth of Thomas Say, American naturalist, was observed by the Academy of Natural Sciences, Philadelphia, on July 27, when S. Davis Wilson, mayor of Philadelphia, made the commemorative address.

SCIENTIFIC NOTES AND NEWS

SIR DAVID PRAIN, for seventeen years director of the Royal Botanic Gardens at Kew, celebrated his eightieth birthday on July 11.

DR. KARL BOSCH, Nobel laureate, chairman of the I. G. Farbenindustrie, has been appointed by Bernhard Rust, German minister of education, president of the Kaiser Wilhelm Society for the Advancement of Science.

PROFESSOR ALBERT EINSTEIN has been elected an honorary member of Rho Pi Phi, pharmaceutical fra-

ternity, for "humane service to the nation." Presentation of the membership, signed and sealed in Boston, was made personally to him on July 8 at his summer home in Huntington, Long Island.

BUCKNELL UNIVERSITY has conferred the degree of doctor of engineering on Dr. Clement C. Williams, president of Lehigh University.

ON the occasion of the fortieth anniversary of his graduation from Miami University, the degree of doctor of laws was conferred on Dr. W. J. Hale, director of research of the Dow Chemical Company, Midland, Mich.

THE University of Leeds conferred on July 5 the degree of doctor of laws on Dr. John K. Jamieson, formerly professor of anatomy at Leeds, now professor of anatomy and chirurgery at the University of Dublin.

ELLSWORTH P. KILLIP, of the Division of Plants (National Herbarium), U. S. National Museum, has been authorized through an Act of Congress to accept the award of Chevalier of the French Legion of Honor recently conferred upon him by the French Government.

DR. PAUL RAMDOHR, professor of mineralogy at Berlin, has been elected a member of the Swedish Geological Society.

AT a recent meeting of the Central Pennsylvania Branch of the Society of American Bacteriologists the following were elected officers for the coming year: *President,* Dr. Edward J. Pugh, Kirby Memorial Health Center, Wilkes-Barre; *Vice-president,* Dr. J. H. Brown, The Gilliland Laboratories, Marietta; *Secretary-treasurer,* Dr. M. A. Farrell, the Pennsylvania State College.

NEWLY elected officers for 1937–38 of the New England Section of the American Society of Plant Physiologists are: *chairman,* Dr. F. H. Steinmetz; *vice-chairman,* Dr. H. B. Vickery, and *secretary-treasurer,* Dr. L. H. Jones.

EFFIE JANE TAYLOR, professor of nursing and dean of the Yale University School of Nursing, has been elected president of the International Congress of Nurses, which opened in London on July 19.

DR. HARRY PARKER HAMMOND, head of the department of civil engineering at the Polytechnic Institute of Brooklyn, has been appointed dean of the School of Engineering at the Pennsylvania State College. He succeeds Dr. Robert L. Sackett, who retired on July 1.

DR. DAVID W. E. BAIRD, associate professor of medicine at the school of medicine of the University of Oregon, has been named associate dean, succeeding Dr. Myers. Dr. Baird has been medical director of the clinic and hospital.

DR. ARCHIE NORMAN SOLBERG, fellow at Columbia University, has been appointed associate professor of biology at the University of Toledo to succeed the late John M. Condrin.

THE following promotions have been made at Bard College, Columbia University: Dr. Harold Mestre, from visiting associate professor and fellow in biophysics to professor and director of studies; Dr. C. Theodore Sottery, from associate professor and fellow to professor of chemistry; Dr. C. R. Carpenter (on leave of absence with the Asiatic Primate Expedition), from lecturer and fellow in psychology to assistant professor; Dr. Francis M. Summers, from instructor and tutor in biology to assistant professor and fellow; Edward C. Fuller, from instructor and tutor in chemistry to lecturer and fellow.

DR. NOAH MORRIS, lecturer in pathological biochemistry in the University of Glasgow, has been appointed regius professor of materia medica in the University of Glasgow in place of Professor Ralph Stockman, who has resigned.

AT the Museum of Science and Industry, Chicago, Dr. F. C. Brown, director of the Annual Science Exhibit of the American Association for the Advancement of Science, formerly director of the Museum of Science and Industry, New York, has been appointed curator of physics, and Dr. C. R. Moulton, of Northwestern University, curator of chemistry.

DR. IRVINE H. PAGE, associate of the Hospital of the Rockefeller Institute for Medical Research, New York, will assume charge of the research department of the Indianapolis City Hospital on September 15. He will be retained for the post by Eli Lilly and Company, which cooperates with the hospital in laboratory and research work.

DR. WILLIAM D. TURNER has been appointed research psychologist at the Institute of the Pennsylvania Hospital, Philadelphia, where he will conduct, among other projects, an investigation of psychological changes in schizophrenic patients receiving the insulin-shock treatment.

DR. VALY MENKIN, of the department of pathology of the Harvard Medical School, has received a grant of $4,000 for two years from the International Cancer Foundation for work on the relationship to the development of experimental neoplasia of the substance leukotaxine, which he recently isolated from inflammatory exudates.

THE John and Mary R. Markle Foundation has made a grant of $10,000 to Dr. H. P. Smith, of the department of pathology of the State University of Iowa, for research on blood clotting and the bleeding tendency.

THE Kentucky Academy of Science recently awarded a research grant to Dr. John B. Loefer, of Berea College, for the purchase of new equipment for investigations on the biochemistry of protozoa.

THE third university fellowship of 1937 for advanced study in radio broadcasting with the National Broadcasting Company has been awarded by the General Education Board to H. M. Partridge, program director of the New York University Radio Committee. The appointment is for three months, ending on October 1.

A GRANT of two thousand dollars has been awarded by Cinchona Products Institute, Inc., of New York to Dr. J. P. Sanders, of Caspiana, La., for research on malaria.

A SERIES of free public lectures on consecutive Monday evenings by members of the staff has been inaugurated at the Scripps Institution of the University of California. The lectures are in non-technical language and will describe the past and present activities of the Scripps Institution. Members of the staff who will speak include Dr. H. U. Sverdrup, director; Dr. F. B. Sumner, Dr. R. H. Fleming, Dr. C. E. ZoBell, Dr. M. W. Johnson and Dr. D. L. Fox.

THE regular summer meeting of the Pennsylvania Academy of Science will be held at Wellsboro, on August 14 and 15. Field trips will include areas of geologic, physiographic, botanic and zoologic interest. Further information can be obtained from the secretary, Dr. V. Earl Light, Lebanon Valley College, Annville, Pa.

THE American Public Health Association will hold its annual meeting in New York City from October 5 to 8. Speakers at the opening general session include Dr. Parran, Mayor LaGuardia, Governor Lehman and Dr. Farrand. Dr. McCormack, president-elect of the association, will speak at the dinner. There will be special sessions on mental hygiene, the hygiene of housing and on the advancement of public health. Among the subjects chosen for joint sessions are nutritional problems with the Sections of Child Hygiene and Nutrition; water-borne diseases with the Sections of Public Health Engineering and Epidemiology; the crippled child, with the Sections on Child Hygiene and Public Health Nursing, and syphilis in industry with the Sections on Industrial Hygiene and Public Health Nursing. The American Association of School Physicians, the National Organization for Public Health Nursing, the Federation of Sewage Works Operators and several other allied national groups will join with the American Public Health Association in a series of scientific sessions. Inquiries should be addressed to the American Public Health Association, 50 West 50th Street, New York City.

ESTABLISHMENT of an annual award for research in surgery of $1,500 was announced at a recent meeting in New York City of the executive council of the United States Chapter of the International College of Surgeons. The council in addition will award a gold medal and scroll of honor. Winners will be selected on the basis of original papers submitted to a committee of the International College of Surgeons in Geneva. The first awards will be made at the meeting of the International College in 1938. Their purpose is "to stimulate original research in all major branches of surgery."

BY the will of George F. Baker, Jr., who died on May 30, leaving an estate worth in the neighborhood of $100,000,000, a trust fund of $15,000,000 is established. His trustees and executors are instructed to devote the net income of the charity trust to corporations organized exclusively for religious, charitable, scientific, literary or educational purposes.

THE appraisal of the bequest of $1,000,000 made to Duke University in the will of Mrs. Benjamin N. Duke shows that the amount will be reduced to $420,052 after payment of federal and state inheritance taxes.

THROUGH the adjudication of the estate of the late Miss Frances T. Kinsey, the University of Pennsylvania has been awarded approximately $200,000 to establish and maintain the "Kinsey-Thomas Foundation for the Study and Treatment of Diseases of the Digestive System." Dr. T. Grier Miller, professor of medicine at the Medical School, will have charge of the foundation.

A BOTANICAL garden and arboretum, devoted to the study of wild native plants growing in northern Indiana, were dedicated on June 12 by Huntington College, Indiana. Dr. Ernst A. Bessey, professor of botany at the Michigan State College, gave the dedication address. Botanists and representatives from several colleges and universities in the state were present. The garden, which comprises about three and a half acres of gently sloping land, includes at this time more than 300 species of plants, arranged in family groups as far as possible and each species is labeled with both scientific and common names. It is planned to devote one section entirely to native grasses. The arboretum comprises about forty acres of broken and picturesque land, now well wooded with many of the trees and shrubs native to the territory. Others will be planted until it is complete. The development of this garden and arboretum, which is the only project of its kind in the state and one of few in the United States, is the work of Fred A. Loew, professor of botany, and has been named after him. Professor Loew

received his training under the late Dr. William James Beal, of Michigan. In his address, Dr. Bessey briefly outlined the history of botanical gardens throughout early and modern times and stressed their value to colleges and schools of to-day. He pointed out that not only is such a garden of value to the school, but it becomes a center of interest for all persons of the community as it preserves many types of vegetation, flowers and trees which have or may become practically extinct.

DISCUSSION

MICROCLIMATIC STUDIES IN OKLAHOMA AND OHIO

IN October, 1935, the Soil Conservation Service, in cooperation with the Weather Bureau and with funds supplied by the Works Progress Administration, established 200 weather stations spaced about three miles apart throughout Blaine, Kingfisher and Logan Counties in Oklahoma. Each was supplied with a rain gage, anemometer, wind vane, psychrometer and thermometers, and was operated by a farmer from the relief rolls.

The results obtained were of sufficient value to justify the establishment, in March, 1937, of a similar microclimatic study in the Muskingum Valley in Ohio by the Soil Conservation Service in cooperation with the Weather Bureau and the Muskingum Watershed Conservancy District, with funds supplied by the Ohio Works Progress Administration. Here 500 weather stations, each including a self-recording rain gage in addition to the instruments supplied in Oklahoma, were spaced approximately four miles apart in the 8,000 square miles of the watershed.

At both projects the records obtained by the observers are mailed to headquarters daily and are used in the preparation of detailed climatic maps, the most significant of which are those of rainfall. Those for the Oklahoma Climatic Center show the rainfall distribution for every fifteen-minute interval and the accumulation of rainfall by fifteen-minute intervals for each storm. In Ohio similar maps are prepared for half-hour intervals. Distribution maps of temperature, relative humidity, fog, dust and wind velocity and direction are prepared to help explain the rainstorms and to permit their classification into types. Supplementary maps show the rainfall accumulation for each day on which rainfall occurred and the daily accumulations for each month as well as for the entire year.

More than a year of records had accumulated in Oklahoma before the Ohio project was established. The maps prepared from the Oklahoma records revealed many facts that have a fundamental bearing on climatology and meteorology.

The battery of rain gages is regarded as a single instrument for obtaining simultaneous samples in different parts of rainstorms in sufficient number to determine their characteristics. During the course of the study a large number of storms have been sampled in this manner. Rainstorms are subject to the same kind of observation and classification as other phenomena, and through the analysis of those observed a beginning on a taxonomy of rainstorms has been made. It has been found that rainstorms have characteristics of size, shape, internal structure, distribution of intensity and migration patterns.

Ignorance of the morphology of rainstorms has prevented the interpretation of the precipitation records of a single station in terms of the storm that produced it. Hence, in the past, much emphasis has been placed on detailed statistical treatment of precipitation records of single stations and very little on the areal distribution and characteristics of individual storms.

Two types of rainstorms, distinctive as to form, internal structure and behavior pattern, have been recognized. One type, of comparatively short duration and high intensities (the cold front type), is especially significant in the production of gully and sheet erosion and occasional local floods. The other type, of long duration and lower intensities, but ordinarily bringing larger amounts of rainfall (the warm front type), is significant in stimulating mass or gravity movements of soil, such as slumping, field slides and caving of gully walls and heads, and is invariably the cause of major floods.

The Ohio study is especially important because it covers an entire drainage area which is one of the outstanding flood control laboratories in the country. A forty-million dollar flood control and water conservation project is now being constructed cooperatively by the Federal Government, the State of Ohio and the Muskingum Watershed Conservancy District. The operation of the project will be of continuing value to all three of these agencies.

The Muskingum watershed offers an ideal location for such a study, since the Muskingum Watershed Conservancy District, in cooperation with the U. S. Geological Survey and the Soil Conservation Service, operates more than thirty stream-gaging stations and will as soon as they are constructed be operating fourteen flood control dams and reservoirs, and since the Soil Conservation Service has already established in the center of the area an extremely detailed study of rainfall and runoff and of the influence of agronomic practices on runoff.

On the Ohio project the rainfall maps are being used as in Oklahoma for the study of rainstorm morphology, but in addition they will be used to determine the amount of rainfall and the time of its occurrence on the minor watersheds above stream-gaging stations. These data will be related to the runoff as measured at the gaging stations in the expectation that it will be possible to forecast discharge and stage from the records of selected rain gages.

Rainstorm morphology is seen to have implications in a number of related fields. It reveals the limitations in existing determinations of rainfall intensity-frequency and indicates ways in which such determinations may be improved; it suggests a new approach to the problem of flood hazards and forecasting; has a definite bearing on the statistical study of the relation between climate and crop yields, and suggests important refinements in soil erosion experiments. In addition, it raises the suspicion that variations in annual rainfall may be due to the random distribution of individual rainstorms, in which case forecasting of rainfall through extrapolation would be quite impossible. The maps of wind velocity and direction have revealed facts regarding the characteristics of surface fronts, of basic importance to air mass studies in meteorology, which could not have been obtained in any other way. The value of these microclimatic studies lies not so much in continued observations over a long period of years as in the obtaining of simultaneous observations at sufficiently short intervals to permit the study of many individual rainstorms. In a few years enough could be learned about the characteristics of storms in these two areas to make it possible to approach the climatic problems relating to soil and moisture conservation, land use and flood control on a more intelligent basis.

C. W. THORNTHWAITE
SOIL CONSERVATION SERVICE,
WASHINGTON, D. C.

CHROMOSOME ALTERATIONS BY CENTRIFUGING

IN my previous publications[1] I showed that in centrifuging of germinated seed of *Vicia Faba, Nicotiana Langsdorffii,* wheat, etc., various alterations were induced in the somatic chromosome sets. Monosomic, trisomic, tetrasomic and polysomic cells and cell regions were found as well as such with tetraploid and hypertetraploid chromosome number. Occasionally cells with chromosome fragments were also observed. A student of mine (I. Rajably) induced the same chromosome alterations by centrifuging in barley, *Vicia sativa* and in *Matthiola.* He even produced a tetraploid *Matthiola* plant.

[1] D. Kostoff, *Archivio Botanico,* 11: 91–96, 1935; *Compt. Rend. Acad. Sci. USSR,* 2: 71–76, 1935; *Zeitschr. Induct. Abstamm. Vererbungslehre,* 69: 301–302, 1935.

The results of my more recent experiments are:

(1) *Nicotiana Langsdorffii.* Besides the chromosome alterations, I obtained in F_2 generation a variegated plant (leaves and flowers), which gave in F_3 green: variegated : white, in various ratios, depending on the capsule from which the seed was collected. I grew during the last twelve years each year thousands of seedlings of *N. Langsdorffii,* from which only 30 to 100 were usually transplanted for raising adult plants; nevertheless, I never have found variegated seedlings among those I grew. It should be mentioned here that variegated plants develop only from variegated seedlings.

(2) *Crepis capillaris.* Professor Dr. G. Lewitzky, of Leningrad, sent me kindly seed from *Crepis capillaris,* for which I wish to express here my gratitude. Centrifuging germinating seeds, collected last year, chromosome alterations were induced as those mentioned above, involving A, B and D chromosome.

(3) *Hybrid. Nicotiana rustica* × *N. tabacum.* A large number of seed was produced by crossing *N. rustica* with *N. tabacum.* Germinated seed were centrifuged and then transplanted. Many of them died. One plant out of 81 adult hybrids came out to be a chromosome chimera, forming a branch with doubled chromosome number ($2 \times 48 = 96$). This branch was self-fertile, giving rise further to amphidiploid *N. rustica* × *tabacum,* while all F_1 hybrids and the other branches of the chromosome chimera were self-sterile.

A more detailed description of the experiments will be given later.

DONTCHO KOSTOFF
INSTITUTE OF GENETICS, ACADEMY OF SCIENCES OF USSR, MOSCOW

A SIX-CHROMOSOME ASCARIS IN CHINESE HORSES

A BRIEF note with the above title was published in Volume 9 of the *Peking Natural History Bulletin* in December, 1934. As that scientific journal does not have a wide circulation in America, and the chromosomes of *Ascaris megalocephala bivalens* and *univalens* have had so much historical and practical value for biologists, I am asking for the privilege of announcing this discovery in SCIENCE. The first material came from six worms brought to this laboratory by a man who had been asked to collect Ascaris from Chinese horses because we wanted to make our own slides to illustrate mitosis and maturation phenomena for classwork. In 1935 he brought six more, but these were all dead, and now this year he has brought twenty-two new ones in very good condition, and we have plenty of material to work out oögenesis, spermatogenesis and cleavage.

The behavior of the chromosomes is just the same as in the classical Ascaris material, except that there

are three pairs in the oogonium, spermatogonium and fertilized egg, and three tetrads or dyads in the maturation divisions of the egg and sperm. In the 1934 note it was suggested that this form might be called *Ascaris megalocephala trivalens,* and might be a case of polyploidy; or perhaps should be considered more primitive than *bivalens* or *univalens,* as the Mongolian pony (the common horse in China) is a primitive animal. From this new and abundant material I have noticed certain morphological differences in size and shape which make me wonder whether its relationship to *megalocephala* may not be quite so close. Diminution takes place in the somatic cells, as in the classical Ascaris, but it looks as though the somatic chromosome number may be less.

All these points will be worked out carefully and published with drawings in a later number of the *Peking Natural History Bulletin* within this year.

JU-CHI LI

YENCHING UNIVERSITY, PEIPING

IN RE HYPOTHECATE

THE erroneous use of "hypothecate" is justly condemned in your issue of June 25 by Professor A. V. Hill. The error is an instance of the common confusion of two words somewhat similar in sound but differing in meaning. The sentence criticized read, "Each hypothecated element in the nerve," etc. "Hypothetical" was evidently what the writer intended. It is a useful word, somewhat more specific than "assumed," which Dr. Hill recommends, since it implies an assumption made in accordance with a previously stated hypothesis. So in banishing "hypothecated" in its erroneous sense, let us not dismiss with it the useful words "hypothetical" and "hypothesized."

L. A. HAWKINS

GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

THE interest constantly shown by SCIENCE in matters of diction prompts this note. In regard to the misuse of the word "hypothecate" in the sense of "assume," to which A. V. Hill takes justifiable exception in your issue of June 25, I would call attention to the word "hypothesize," which has exactly the sense and sound desired by many authors in certain cases and which is in good standing in the dictionaries. Perhaps, though, the more common verb *postulate* would serve in such cases equally well.

In your next *index expurgatorius* please put a lasting curse on the following atrocities: "Spacial" (for spatial); "Causal" (in the sense of *causative*); "Humans" (for human beings); "Do an experiment on. . . ."

T. J. MOSLEY

U. S. FOREST PRODUCTS LABORATORY
MADISON, WIS.

SOCIETIES AND MEETINGS

THE AMERICAN GEOPHYSICAL UNION

THE eighteenth annual general assembly of the American Geophysical Union and the meetings of its seven sections were held from April 28 to 30, 1937, at Washington, D. C., in the buildings of the National Academy of Sciences and the National Research Council, the Smithsonian Institution and the U. S. Geological Survey.

The scientific session of the general assembly was devoted to a symposium on theoretical and observational considerations of importance to further studies of the depths of the earth. Five formal papers presented were: "On the Estimation of Temperatures at Moderate Depths in the Crust of the Earth," by C. E. Van Orstrand; "The External Gravity-Field and the Interior of the Earth," by W. D. Lambert; "Deep-Focus Earthquakes and Their Implications," by J. B. Macelwane; "The Earth's Interior as Inferred from Terrestrial Magnetism," by A. G. McNish; "The Behavior of Matter under Extreme Conditions," by P. W. Bridgman. After an extended discussion, the symposium was summarized by L. H. Adams. Detailed reports were received from two special committees, namely, (1) on geophysical and geological study of oceanic basins and (2) on geophysical and geological study of continents.

Ten resolutions were adopted. Two of these expressed thanks for privileges extended by the Smithsonian Institution and by the U. S. Geological Survey. The importance of the United States time-signals for the economical and efficient continuation of many scientific projects of a geophysical nature was emphasized, with expressions of appreciation for that service to the Naval Observatory and the Bureau of Navigation of the United States Navy. Another resolution called attention to the splendid cooperation of the Bell Telephone Laboratories in lending its improved crystal-chronometer for the recent gravity-at-sea expedition; this crystal-chronometer greatly increased the precision obtained.

The results of the third expedition for gravity-work at sea by the United States Navy during September 1936, to January, 1937, in cooperation with the university and other organizations, form an invaluable contribution to the investigation of oceanic areas; the union expressed the hope that the United States Navy would continue to promote such important work whenever

practicable. Another resolution expressed thanks to the American Philosophical Society for its grant which provided for certain expenses of the third gravity-expedition that were not otherwise provided for.

The importance of providing the Pennsylvania State College with a modern and well-equipped seismological observatory for the continuation and extension of seismological investigations and cooperative work was stressed. Another resolution pointed out the potential value of encouragement and endorsement of the action of the Eastern Section of the Seismological Society of America in the formation of its Committee on Amateur Seismology.

The union heartily commended, as an effective means of furthering American meteorology and safe flying, the five-year program of research and instruction proposed by the Blue Hill Meteorological Observatory and urged airlines, individuals and research foundations to support this program.

A resolution on the collection of basic data in hydrology made formal recognition of the foresight of agencies, both federal and non-federal, who have preserved invaluable records in hydrology, and recommended encouragement in further collections of such data and the program outlined by the Water Resources Committee.

J. A. Fleming was reelected general secretary of the union and W. D. Sutcliffe was elected secretary of the section of geodesy, both for three years from July 1, 1937.

The total membership of the union on April 30, 1937, was 928—a net gain of 160 during the past year. Thirty-three of the union's members attended the seventh triennial assembly of the International Union of Geodesy and Geophysics in September, 1936, at Edinburgh, Scotland. The eighth triennial assembly of the international union is to be held in 1939 at Washington, D. C.

In the Section of Geodesy twelve papers and reports were presented. Five of these dealt with progress and development of geodetic operations and instruments in Canada, Central America, Mexico and the United States; six related to gravimetric surveys, apparatus, interpretations and relation of gravity-anomalies and geologic structure; one illustrated the utility of state plane-coordinate systems; and one reported on geodesy at the Edinburgh Assembly.

The Section of Seismology held one session. The twelve communications may be classified as follows: Theoretical interpretations and analysis (4); individual earthquakes and seismic measurements (2); research in engineering seismology and applications (3); seismic instruments (2); progress-report for the United States (1).

The Section of Meteorology heard twelve papers which concerned theoretical meteorology (3), observations and technique (7), areal frequency of tornadoes (1), and meteorology at Edinburgh Assembly (1).

Fifteen communications were received by the Section of Terrestrial Magnetism and Electricity. These related to instruments and technique (3), ionosphere and magnetic correlations (4), cosmic radiation (2), solar relations (3), measures of magnetic activity (1), and terrestrial electricity (2). The secretary submitted brief summaries of progress-reports dealing with magnetic and electric researches by eight organizations in Canada, Peru, Western Australia and the United States, including Alaska, Hawaii and Puerto Rico.

Twelve communications at the meeting of the Section of Oceanography concerned progress during the year of five governmental and private organizations doing oceanographic work in the United States and Canada. Five papers had to do with dynamical oceanography and ocean-currents. Two papers related to North Atlantic deep-sea cores and investigation of submarine topography.

Fifteen papers were submitted and discussed at two sessions of the Section of Volcanology. They dealt with igneous rocks, igneous activity and volcanic formations.

There were four sessions of the Section of Hydrology—three for the presentation of reports and papers, and an evening smoker devoted to informal reports on the Edinburgh Assembly of the International Union of Geodesy and Geophysics and to discussion of plans for the Assembly of that Union scheduled for Washington in 1939. Twenty-seven papers, with discussions, may be roughly grouped as follows: Rainfall, infiltration and ground-water (10); stream-flow and flood-control (8); geophysical methods and technique for determination of underground water (6); and one each on wells, mine-water, snow-surveying and chemical action. The Research Committee on Rainfall and Runoff, because of its extensive field, was divided into two in 1936, namely, on runoff and on rainfall; thus there are now ten permanent research committees in this section. The annual reports of these committees were received and discussed at the three scientific sessions as follows: (1) snow; (2) glaciers; (3) evaporation; (4) absorption and transpiration; (5) runoff; (6) physics of soil-moisture; (7) underground waters; (8) dynamics of streams; (9) chemistry of natural waters; (10) rainfall.

DENVER REGIONAL MEETING

The regional meeting of the Section of Hydrology at Denver, Colo., was arranged by a special committee, of which R. J. Tipton was chairman. Some 44 stimulating papers with discussions were presented during ten scheduled sessions, from June 21 to 26, 1937. At the first session statements were presented by the

president of the union and by the chairman and vice-chairman of the Section of Hydrology on the objectives of the section and on the general scientific and national and international aspects and relations of its field. In the following sessions the papers related to consumptive use and return-flow, rainfall and runoff, physics of soil-moisture, dynamics of streams and underground waters. The two sessions of June 22 were held jointly with the Society of American Foresters, and the nine papers presented will be published in the official organ of that Society. The session on the afternoon of June 24 was devoted to attendance at the symposium of the Ecological Society of America on "The Scientific Aspects of the Control of Drifting Soils." The session during the morning of June 25 and the two sessions of June 26 constituted the South Continental Divide Snow-Survey Conference, concluding with a movie film of snow-surveying and a round-table presentation of experiences and problems in snow-surveying.

TRANSACTIONS

The proceedings of both the annual and regional meetings have been edited by the general secretary for publication by the offset method in two volumes of *Transactions,* the first volume being devoted to papers presented at the general assembly and at the meetings of the Sections of Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography and Volcanology. The second volume is devoted to papers and reports submitted before the Section of Hydrology at the eighteenth annual meetings and at the Denver regional meeting. The *Transactions* include 138 papers and reports, either in full or in abstract, presented at the eighteenth annual meetings, and some 35 papers and reports, not elsewhere published, presented during the meetings at Denver of the Section of Hydrology and of the South Continental Divide Snow-Survey Conference.

These annual and regional meetings afford abundant evidence of the vital scientific and economic importance of geophysics. They further point out many new applications and problems of large immediate and potential value. As a pioneer in the dissemination of information regarding American progress in current geophysical research so vital to human activities, the continued publication of the *Transactions* of the union is an important agency—one which serves to emphasize the urgent need of finding additional suitable means of prompt publication.

JNO. A. FLEMING,
General Secretary

SPECIAL ARTICLES

DETERMINATION OF ULTRA-VIOLET LIGHT ABSORPTION BY CERTAIN BACTERIOPHAGES

SEVERAL workers[1,2,3,4] have recorded quantitative data on the ultra-violet light absorption of various organic materials, proteins, amino acids, nucleic acids, etc. Because such data may eventually throw light on the nature of such materials, it seemed desirable to measure the absorption of ultra-violet light by bacteriophage. This preliminary paper reports the findings of such observations.

The bacteriophages employed, C13, C16 and C36, came from Burnet's collection through the courtesy of Dr. C. H. Andrewes. They were prepared in 2 per cent. peptone (Bacto) water with strain No. 229 (Tittsler) of *Escherichia communior.* Bacteriophage C13 was purified by the modification of the Kligler-Olitzki technique previously reported.[5] Certain pertinent characteristics of these bacteriophages are given in Table 1.

TABLE I
CHARACTERISTICS OF BACTERIOPHAGES AND CONTROL MATERIALS

Bacteriophage	Particle size* in mμ	Plaque size* in mm	Filter exponent of Base 10	Mgm nitrogen per 10 cc
C13	15–20	8–12	9	33.5
C36	20–30	2–6	7	33.2
C16	50–75	0.1–1.2	10	32.9
C13 purified		5–8	12	0.2
2 per cent. peptone water				33.8
Non-lytic filtrate .				34.8

* With the exception of the purified bacteriophage, these values are those recorded by Elford and Andrewes, *Brit. Jour. Exp. Path.,* 13: 446, 1932.

The absorption of ultra-violet light by the preparations of bacteriophage, by the sterile medium and by a filtrate of a young culture of the test organism, was determined by the well-known method of match-point spectrophotometry. Many determinations were made on the same and on different batches of each material that was tested, so that the values reported here represent the averages of not less than five photospectrograms.

The results are recorded in Fig. 1, where the logarithm of the absorption (*i.e.,* the "photographic density") is plotted as a function of wave-length. Although each crude bacteriophage contained practi-

[1] F. L. Gates, *Jour. Gen. Physiol.,* 17: 797, 1933.
[2] J. R. Loofbourow, *Bull. Basic Sc. Res.,* 5: 13, 33, 46, 1933.
[3] C. Hicks and H. Holden, *Australian Jour. Exp. Biol. and Med. Sc.,* 12: 91, 1934.
[4] C. Coulter, F. Stone and E. Kabat, *Jour. Gen. Physiol.,* 19: 739, 1936.
[5] L. A. Sandholzer, *Jour. Bact.,* 32: 358, 1936.

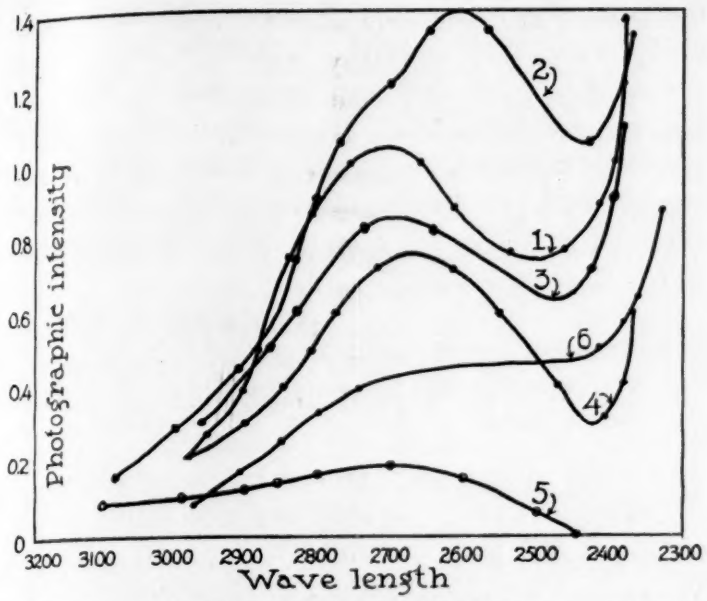

FIG. 1. Absorption of ultra-violet light by bacteriophages and control materials. Bacteriophages were all prepared with *Escherichia communior* grown in 2 per cent. peptone water. (1) Non-lytic filtrate of host organism. (2) Bacteriophage C16. (3) Bacteriophage C36. (4) Bacteriophage C13. (5) Bacteriophage C13 purified by modified Kligler-Olitzki technique. (6) Sterile 2 per cent. peptone water.

cally the same amount of nitrogen and had roughly the same titer, the relative degree of absorption was distinct for each one. All the maxima, however, were found to lie between 2,600–2,700 Å and the minima to fall at about 2,450 Å. The findings suggested that absorption parallels particle size. It will be noted, however, that an exception occurred with the non-lytic filtrate, which fell midway between bacteriophages C16 and C36.

There was significant difference in the quantitative absorption between the crude and purified bacteriophage C13. No change in the wave-length of maximum absorption occurred with the loss of extraneous nitrogenous material.

The determinations with the sterile medium were not entirely satisfactory for technical reasons, but the curve indicates that less ultra-violet was absorbed by it than by the filtrates.

No correlation between the titers of the bacteriophage preparations and their absorption spectra was apparent. Absorption, also, seemed to be independent of nitrogen content, which, with the exception of the purified bacteriophage, was practically constant.

SUMMARY

The absorption of ultra-violet light by three bacteriophages C13, C16 and C36, prepared with a strain of *Escherichia communior* has been determined. Each bacteriophage preparation showed a characteristic absorption curve, when the wave-length was plotted against the photographic density. Crude bacteriophage preparations absorbed more light than one such preparation obtained in a purer state, but the wave-length of maximum absorption remained the same.

LESLIE A. SANDHOLZER
MARVIN M. MANN
GEORGE PACKER BERRY

DEPARTMENTS OF BACTERIOLOGY AND PHYSICS, UNIVERSITY OF ROCHESTER

THE CHEMICAL CONSTITUTION OF BENZOYL GLUCURONIC ACID

THE chemical constitution of benzoyl glucuronic acid has been a subject of controversy ever since the compound was first isolated in the form of the sodium salt by Magnus Levy[1] in 1907. The benzoyl derivative of glucuronic acid is excreted in the urine in relatively large quantities when dogs are fed benzoic acid. Conjugation of aromatic acids with glucuronic acid is one of the important detoxicating mechanisms of man and certain mammals. Benzoyl glucuronic acid itself has been studied more extensively perhaps than any of the other conjugated glucuronides, yet its chemical constitution has never been definitely established.

Magnus Levy believed the derivative to be an ester in which the benzoyl radical is attached to the first or aldehydic carbon atom of the uronic acid. This explanation was generally accepted until 1926, when Quick[2] first isolated the conjugated derivative as the free acid. On the basis of certain polarimetric changes which benzoyl glucuronic acid underwent in faintly alkaline solution, or in the presence of sodium cyanide solution, Quick objected to the formula assigned by Magnus Levy and suggested that the compound is a benzoyl ester substituted not on the first, but on one of the remaining carbon atoms of the uronic acid. This postulation has since been questioned by Pryde and Williams[3] who maintain that the structural formula of Magnus Levy is the more probable. The suggestion, however, is not accepted by Quick[4] with the result that the exact constitution of this biologically important substance still remains uncertain.

The preparation of 1 bromo, 2, 3, 4, triacetyl glucuronic acid methyl ester by the author[5] has made possible the laboratory synthesis both of conjugated glucuronides and of other derivatives of glucuronic acid substituted on the first, or aldehydic carbon atom. If, therefore, the naturally occurring benzoyl glucuronic acid is a β ester substituted in position one as supposed by Magnus Levy, the triacetyl methyl ester derivative of the naturally occurring substance should be identical with the synthetic derivative prepared by

[1] A. Magnus Levy, *Biochem. Zeit.*, 6: 502, 1907.
[2] A. Quick, *Jour. Biol. Chem.*, 69: 549, 1926.
[3] J. Pryde and R. T. Williams, *Biochem., Jour.*, 27: 1210, 1933.
[4] A. Quick., *ibid.*, 28: 403, 1934.
[5] W. F. Goebel and F. H. Babers, *Jour. Biol. Chem.*, 111: 347, 1935.

condensing 1 bromo, 2, 3, 4 triacetyl glucuronic acid methyl ester with silver benzoate.

Benzoyl glucuronic acid was isolated according to the method of Quick from the urine of dogs which had been fed daily doses of benzoic acid. The pure derivative crystallizes from water as needles melting at 184–185°. $[\alpha]_D^{25°} = -26.8°$ in H_2O (C = 0.6 per cent.). The methyl ester of benzoyl glucuronic acid was prepared in excellent yields by treating a methyl alcoholic solution of the free acid at −10° with a slight excess of diazomethane. The compound crystallizes from water as needles melting at 190–191°. $[\alpha]_D^{25} = -16.3°$ in CH_3OH (C = 1.5 per cent.) $C_{12}H_{13}O_6COOCH_3$. Calculated OCH_3 9.92. Found OCH_3 10.13.

The acetyl derivative was prepared by acetylation of benzoyl glucuronic acid methyl ester with pyridine and acetic anhydride at 0°. Triacetyl monobenzoyl

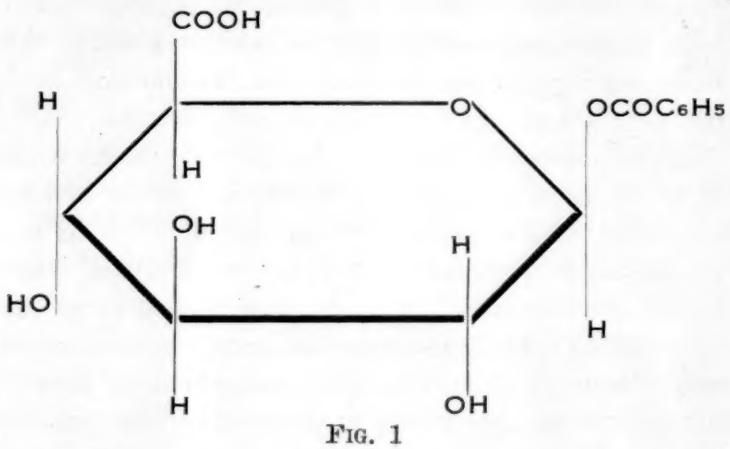

FIG. 1

glucuronic acid methyl ester is formed in yields of 88 per cent., and only one product is obtained from the reaction mixture. When recrystallized from methyl alcohol the substance is obtained as needles melting at 145°. $[\alpha]_D^{28°} = -16.6°$ in $CHCl_3$ (C = 1.5 per cent.) $C_{20}H_{22}O_{11}$. Calculated C 54.77, H 5.06, OCH_3 7.07. Found C 55.10, H 5.26, OCH_3, 7.12.

Synthetic 1 benzoyl 2, 3, 4, triacetyl glucuronic acid methyl ester was prepared by condensing 1 bromo 2, 3, 4, triacetyl glucuronic acid methyl ester (1 mol) with silver benzoate (3 mols) in anhydrous chloroform at 61°. The derivative is formed in yields of 75 per cent. When recrystallized from methyl alcohol the synthetic derivative was found to be identical with triacetyl monobenzoyl glucuronic acid methyl ester prepared from natural benzoyl glucuronic acid. The melting point, crystalline structure, specific rotation and analysis of the two substances are identical. A mixed melting point of the two derivatives shows no depression.

It has previously been shown that 1 bromo 2, 3, 4, triacetyl glucuronic acid methyl ester is a pyranose derivative having the β configuration.[6] The substitution product, 1 benzoyl 2, 3, 4, triacetyl glucuronic acid methyl ester, may therefore be considered as having the same ring structure and configuration. Since the derivative obtained both synthetically and from natural sources is the same, the parent substance, benzoyl glucuronic acid, may be assigned the following structural formula, in which the benzoyl group is attached to the first carbon atom.

WALTHER F. GOEBEL
HOSPITAL OF THE ROCKEFELLER
INSTITUTE FOR MEDICAL RESEARCH
NEW YORK

ON THE MECHANISM OF THE ACTION OF DIGITALIS GLUCOSIDES ON MUSCLE

IN a recent communication,[1] an account was given of certain functional changes which occur in the sartorius muscle of the frog, maintained in oxygen, as a result of previous exposure to a low concentration of ouabain. These changes are, first, an augmentation in both twitch tension and initial heat production, followed later by an abrupt fall in both tension and heat, with an accompanying fall in efficiency, and finally complete loss of excitability. The effects described do not appear as long as the muscle is maintained in the ouabain-Ringer's solution, and after they have developed recovery follows re-immersion in the solution which produced them. This was considered evidence for the formation of a diffusible substance responsible for the toxic effects described, and it was pointed out that the changes are consistent with those caused by the action of potassium escaping from the interior of the cell. It should be emphasized that these effects occur only when the muscle is removed from its fluid environment, and thus do not represent the classical digitalis effects which develop in the intact animal or when the muscle is kept in fluid or perfused. If the digitalis glucosides cause the muscle cell to lose potassium, this process might enter into the mechanism of the production of muscle shortening and other digitalis effects by causing an increase in the calcium-potassium ratio inside the cell. The interest in this possibility is emphasized by the fact that there are in the literature a large number of observations showing the similarity between the effects on the heart of digitalis and calcium, and it is well known that digitalis action is greater in the presence of a high concentration of calcium in the blood or perfusion fluid. The phenomenon of delayed action and accumulation would also receive a satisfactory explanation.

We have carried out some preliminary studies on the changes in potassium content of the frog's sartorius muscle occurring as the result of soaking for several hours in a solution of ouabain. The figures from eight experiments are given in the table. The

[6] R. D. Hotchkiss and W. F. Goebel, *ibid.*, 115, 285, 1936.

[1] *Jour. Pharmacol. and Exper. Therap.*, 60: 101, 1937.

THE EFFECT OF OUABAIN (1:500,000) ON THE POTASSIUM CONTENT OF FROG'S SARTORIUS MUSCLE

Experiment	Time of exposure	Potassium per 100 gm. muscle		Potassium loss
		Control	Ouabain	
	hours	*mgm.*	*mgm.*	*per cent.*
3/31/37	5–1/2	290	242	17
4/3/37	4–3/4	217	174	20
4/7/37	6	308	231	25
4/9/37	6–1/2	293	231	21
4/12/37	7	315	238	24
6/9/37	6	195	99	49
6/11/37	6	227	147	35
6/12/37	7	191	119	38
Average: ..		**255**	**185**	**29**

muscles exposed to a 1:500,000 ouabain concentration in Ringer's solution uniformly show a loss of potassium as compared with the companion control muscles kept in Ringer's solution alone, the average loss in the eight experiments being 29 per cent. The potassium loss in the last three experiments is greater than in the earlier ones, possibly representing a temperature or seasonal variation.

It is to be noted that the concentration of ouabain employed is greater than that obtaining in therapeutic doses. However, striated muscle is relatively resistant to digitalis action, and at the end of the period of exposure to ouabain, these muscles showed no contracture and gave a good contraction when stimulated. The study is being extended to include cardiac muscle and also potassium metabolism in animals receiving therapeutic amounts of the digitalis glucosides.

McKEEN CATTELL
HELEN GOODELL

DEPARTMENTS OF PHARMACOLOGY
AND MEDICINE
CORNELL UNIVERSITY MEDICAL COLLEGE
AND THE NEW YORK HOSPITAL

SCIENTIFIC APPARATUS AND LABORATORY METHODS

UNIFORM TISSUE SECTIONS FOR WARBURG TECHNIQUE[1]

WHEN the metabolism of a section of excised surviving tissue is to be measured and related to unit weight of tissue, there must be a limiting section thickness which is dependent upon the magnitude of the metabolism and the diffusion constant of the reacting substances. Warburg[2] has discussed this subject and from theoretical considerations determined that, if "the tissue section is to breathe in all its parts, it must be thinner than 4.7×10^{-2} cm, if it breathes in pure oxygen, and thinner than 2.1×10^{-2} cm if it breathes in air."

This paper is concerned with a simple method for the preparation of satisfactory tissue sections. Two razor blades of the Gillette type are separated by a thin metal strip and attached to a handle, as shown in Fig. 1.

Immediately after removal from the animal, the tissues to be sectioned are laid on a filter paper moistened with physiological salt solution and held in position with the thumb and forefinger of one hand. The cutting instrument is dipped in the salt solution and the excess solution shaken off. Holding the razor blade edges at an angle approximately 45° to the plane of the filter paper, the instrument is drawn across the tissue with sufficient downward pressure to permit a clean cut. The cut section of tissue is removed from between the razor blades and weighed on a microtorsion balance. While the tissue is suspended on the

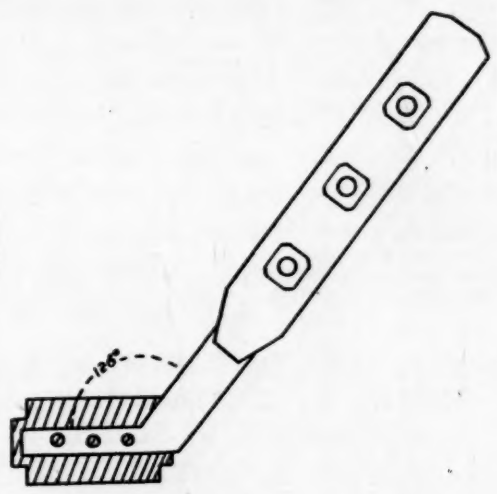

FIG. 1. Sketch showing construction of cutting instrument.

balance, it is possible to clip off a portion of the tissue with a small pair of scissors so as to give a tissue section of desired weight. In this manner, it is possible to place tissues of approximately the same weight and thickness in a series of Warburg vessels. Since the amounts of tissue in a series of vessels are nearly equal, the manometer readings show the trend of results while the experiment is in progress.

Experimental proof that tissue sections cut in this manner are thin enough to permit the tissue to respire in all its parts was obtained in the following manner. By placing metal strips of different thicknesses between the razor blades, albino rat liver sections of varying thicknesses were made and floated in a Petri dish over coordinate paper. The tissue sections were trimmed to equal areas, approximately 100 square millimeters, placed in the Warburg vessels, and oxygen consumption measured in a phosphate buffer solution of pH 7.3 containing 0.1 per cent. dextrose. Folding

[1] From the Bureau of Chemistry and Soils, U. S. Department of Agriculture, at the Department of Pharmacology, Stanford University School of Medicine, San Francisco, Calif.

[2] O. Warburg, *Biochem. Zeitschr.*, 142: 317, 1923.

of the tissue sections was prevented by small platinum hooks anchored to the central absorption chamber. "KOH-papers" were placed in the central absorption chambers of the Warburg vessels as recommended by Dixon and Elliott[3] to facilitate absorption of carbon dioxide evolved during respiration. Upon completion of the experiment the tissues were dried to a constant weight at 105° C, and the wet weight calculated by multiplying the dry weight by 5, the factor used by Warburg.[2]

In four typical experiments the cutting edges of the instrument were separated by a strip of metal 0.3 mm thick. The dry weights of the tissue sections were 7.4, 7.5, 7.4 and 7.2 mgm, corresponding to wet weights of 37.0, 37.6, 37.3 and 36.0 mgm, respectively, when multiplied by the factor of 5. The wet weights obtained by direct weighing were in substantial agreement, being 41.0, 40.5, 40.0 and 40.5 mgm, respectively. The calculated thickness of the tissue sections were within the limit specified by Warburg, being 4.1×10^{-2}, 4.05×10^{-2}, 4.0×10^{-2} and 4.05×10^{-2} cm, respectively. The Q_{0_2} values, based on dry weight, were of the proper magnitude, namely, -10.0, -10.5, -9.7 and -9.9 cu mm. When the cutting edges were separated by approximately 0.6 mm, the thickness of the tissue exceeded the maximum value specified by Warburg, and a Q_{0_2} value of -7.2 cu mm showed that the tissue did not respire in all its parts.

JOHN O. THOMAS
FLOYD DE EDS

AMMONIUM FLUORIDE FUSION: A RAPID MEANS OF DETERMINING POTASSIUM IN SOILS

ORIENTATION data in the study of soil fertility problems require quick and reasonably reliable methods for determination of the major plant food elements in soils. In the case of total potassium a less time-consuming procedure than is now available for accurate estimation of the element would be of distinct advantage in many investigations.

Studies by Shead and Smith[1] showed that it was feasible to decompose refractory silicates with fused ammonium fluoride, with reduction of the time required for fusion to as low as approximately ten minutes. Although their work was limited to the determination of silica in glass sand, their data showed that other constituents were not lost; and since potassium would likewise remain in the non-volatile residue, the procedure offered promise for the determination of potassium.

In preliminary experiments with application of an adaptation of Shead and Smith's procedure to a number of tropical soils, the time required for determination of potassium has been reduced as much as one half; and approximately 80 to 92 per cent. of the value for K, as determined by a modification of the classical J. Lawrence Smith method,[2] has been obtained.

The technical grade of ammonium bifluoride suggested by Shead and Smith has proved somewhat more satisfactory than the fluoride, and it is believed, therefore, that the technique required to make this method of decomposition applicable to all kinds of soils can be developed to such a point that the time required for the determination can be materially reduced, and the accuracy of the determination of potassium improved. Details of the procedure as developed will be published at a later date.

R. B. DEEMER
JAMES B. MARTIN
PAUL R. DAWSON

SOIL FERTILITY INVESTIGATIONS,
BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF
AGRICULTURE

[3] M. Dixon and K. A. C. Elliott, *Biochem. Jour.*, 24: 820, 1930.

[1] A. C. Shead and G. F. Smith, *Jour. Am. Chem. Soc.*, 53: 483–486, 1931.

[2] C. G. Hopkins, "Soil Fertility and Permanent Agriculture," pp. 631–632, 1910; and S. R. Scholes and V. E. Wessels, *Chem. Analyst*, 25: 38–39, 1936.

BOOKS RECEIVED

BROOKES, HENRY S., JR. *Textbook of Surgical Nursing.* Pp. 636. 233 figures. Mosby. $3.50.

DYSON, SIR FRANK and R. V.D. R. WOOLLEY. *Eclipses of the Sun and Moon.* Pp. viii + 160. 32 figures. 11 plates. Oxford University Press. $5.00.

EAGLE, HARRY. *The Laboratory Diagnosis of Syphilis.* Pp. 440. 27 figures. Mosby. $5.00.

EPSTEIN, PAUL S. *Textbook of Thermodynamics.* Pp. xii + 406. 64 figures. Wiley. $5.00.

HOPKINS, B. SMITH. *General Chemistry for Colleges.* Revised edition. Pp. vi + 758. 262 figures. $3.72. *Laboratory Exercises and Problems in General Chemistry.* B. SMITH HOPKINS and M. J. COPLEY. Third edition. Pp. xii + 234. 29 figures. $1.76. Heath.

KANTOR, JOHN L. *Synopsis of Digestive Diseases.* Pp. 302. 40 figures. Mosby. $3.50.

MACKINNEY, LOREN C. *Early Medieval Medicine.* Hideyo Noguchi Lectures. Pp. 247. Johns Hopkins Press. $2.75.

National Resources Committee Report. *Technological Trends and National Policy, Including the Social Implications of New Inventions.* June, 1937. Pp. viii + 388. 73 figures. U. S. Government Printing Office. $1.00.

Nauka Polska. Vol. XXII, Pp. ix + 433. Wydawnictwo Kasy Imienia Mianowskiego; Instytutu Popierania Nauki-Warszawa-Palac Staszica-1937. Warszawa.

PARRAN, THOMAS. *Shadow on the Land: Syphilis.* Pp. ix + 309. Illustrated. Reynal and Hitchcock. $2.50.

PEARSON, HENRY G. *Richard Cockburn Maclaurin, President of the Massachusetts Institute of Technology, 1909–1920.* Pp. 302. Illustrated. Macmillan. $3.00.

Studies of the Institutum Divi Thomae. Vol. I, No. 1, June, 1937. Pp. 135. 13 figures. 4 plates. Institutum Divi Thomae of the Athenaeum of Ohio, Cincinnati.

WENT, F. W. and KENNETH V. THIMANN. *Phytohormones.* Pp. xi + 294. 62 figures. Macmillan. $4.00.